Journal of
Environmental
Nanotechnology

Studies on Nano Naturals dyes obtained from the flower of *Tecoma capensis*

M. Kumaresan*
Department of Chemistry, Arasu Engineering College, Kumbakonam, Tanjore, TN, India
Received: 23.12.2020 Accepted: 22.02.2021
*mkumsrenu@gmail.com

ABSTRACT

In this study, natural colours were produced from the flower of *Tecoma capensis*. The dyes were extracted from the petal part of the plant using the solvent extraction method of acidified methanol. The natural colours were then converted into a powder form that is in nanosize scale using a ball mill grinder. Cotton fabrics were used as the substrate and dyed using several natural and synthetic mordant. The use of different solvents for extraction and mordant for dyeing resulted in different colour shades on the cotton fabrics. The colorfastness to washing tests revealed colour fastness to washing ranging from 4 - 4/5 and the change in color ranging from 2/3 - 3/4. The findings will benefit and promote the dyeing and printing industry.

Keywords: Cotton; Nano; Natural dye; *Tecoma capensis*.

1. INTRODUCTION

Natural dyes or colourants have been used since ancient times. Recently, the use of natural dyes imparts colour for textiles, pots and decorative purposes. Recently, there is an interest in the use of natural dyes; due to the result of stringent environmental standards was given by many countries. The main reason is the toxic and allergic reactions associated with synthetic dyes. Mostly the environmental pollution is due to the discharge of dyeing industry effluents which results in more pollution problems. In ancient days nearly 200 years before, all dyes were natural substances derived from minerals, plants and animals used for various applications. The natural dyes obtained from the parts of various plants and animals are colour giving molecules (Boonroeng et al. 2009) that impart colour to the textile materials.

Fig. 1: ***Tecoma Capensis***

The present investigation deals with the extraction of natural dyes from the flower Tecoma Capensis grows to 2-3 m (7 – 10 ft) in height and a similar width. Normally evergreen, it may lose its leaves in colder climates. It may scramble in certain habitats, meaning that it shoots out long growth tips that lean on the stems and branches of other plants grow in all warm and damp parts of India. The flowers are tubular, narrow, about 7.5 cm (3 in) long, and are produced at different times throughout the year. They are grouped in 10–15 cm (4–6 in) long terminal clusters. The flower colour ranges from orange to orange-red to apricot.

Tecoma capensis has been in cultivation for many years and is often used for hedging, as it is a scrambling shrub. It can be propagated from cuttings or by removing rooted suckers during the active growth phase. It can be planted in semi-shade to full sun. Tolerating temperatures down to 5 °C (41 °F), it can be grown in mild temperate areas with the protection of a warm wall. Otherwise, it can be grown in a container and taken indoors through the winter months.

2. MATERIALS & METHODS

2.1 Materials

Conventionally desized, scoured and H2O2 (1%), a plain cotton fabric (220 ends/ dm, 180 picks/dm,120 g/m2) fabric obtained from Gandhi Trust, Dindugal, was used for this study. Analytical reagents (AR) grade stannous chloride, potassium dichromate aluminium sulphate, nickel sulphate, ferrous sulphate, commercial-

grade acetic acid, common salt, sodium carbonate were used. An excellent natural mordant myrobolan (Terminalia chebula) powder was used for the study. Depending upon the mordant used, the flower of Tecoma capensis extract gave varieties of shades.

2.2 Methods

2.2.1 Extraction of colour component

For the optimizing process, the ethanol extraction of dye liquor was carried out under varying conditions, such as the temperature of extraction, time of extraction, and material-to-liquor ratio. In each and every case, the optical density or absorbance value at a particular maximum absorbance wavelength (λ420nm) for the ethanol extract of plant parts were estimated by using Hitachi-U-2000 UV-VIS absorbance spectrometer.

2.2.2 Dyeing of cotton with the extract of flower of Opuntia ficus-indica

The wetted out samples of cotton were entered into dye baths containing the required amount of dye extract and water. After 10 minutes, the required amount of sodium carbonate and sodium chloride were added. The dyeing was carried out for one hour at 60 °C. The samples were dried in air without washing to make them ready for pre, simultaneous and post-mordanting using myrobolan and metallic salts.

2.2.3 Pre-Mordanting of fabric with myrobolan and metallic salts

The cotton samples with or without pre-mordanting were further mordanted prior to dyeing using 1-3% of any one of the chemical mordants, such as stannous chloride, nickel sulphate, potassium dichromate, aluminium sulphate, copper sulphate and the myrobolan, at 60 °C for 30 min with a material-to-liquor ratio of 1:20. Then the cotton samples were treated with metal salts followed by the dye extract.

2.2.4 Simultaneous mordanting of cotton samples with myrobolan and metallic salts

The cotton samples were treated with both dye extract and metal salts simultaneously, using 1-3% of any one of the chemical mordants, such as potassium dichromate, stannous chloride, copper sulphate, aluminium sulphate, nickel sulphate and the myrobolan, at 60°C for 30 min with a material-to-liquor ratio of 1:20.

2.2.5 Post-Mordanting of cotton samples with myrobolan and metallic salts

The samples were dyed with dye extract. The cotton samples were entered into different dye baths containing the required amount of dye extract and water. After 10 minutes, the required amount of sodium sulphate was added. After 20 minutes, the required amount of sodium chloride was added. The dyeing was carried out for one hour at 50 °C. The dyed cotton samples were taken out, squeezed, and used to treat the metal salts process without washing. The dyed samples were treated with different metal salts using 1-3% of any chemical mordant, such as potassium dichromate, stannous chloride, aluminium sulphate, nickel sulphate copper sulphate and the myrobolan, at 60 °C for 30 min with a material-to-liquor ratio of 1:20.

After the dyeing is over in all three dyeing methods, the dyed samples were repeatedly washed with water and then dried in air. Finally, the dyed cotton samples were subjected to soaping with 2gpl soap solution at 50 °C for 10 min, followed by repeated water wash and drying under sunlight.

2.2.6 Determination of surface colour strength (K/S value)

The K/S value of the undyed and dyed sample was determined by measuring surface reflectance of the samples using a computer-aided Macbeth 2020 plus reflectance spectrophotometer, using the following Kubelka Munk equation with the help of relevant software:

$$K/S = \frac{(1- R_{\lambda\,max})^2}{2R_{\lambda max}} = \alpha\, C$$

K is the coefficient of absorption; S the coefficient of scattering; Cd, the concentration of the due and Rλmax the surface reflectance value of the sample at a particular wavelength, where maximum absorption occurs for a particular dye/colour component.

2.2.7 Evaluation of Colour Fastness

The colour fastness to washing of the dyed samples was determined as per IS: 764 – 1984 method using a Sasmira launder-O-meter following Is-3 wash fastness method. The wash fastness rating was assessed using greyscale as per ISO-05-A02 (loss of shade depth) and ISO-105-AO3 (extent of staining) and the same was cross-checked by measuring the loss of depth of colour and staining using Macbeth 2020 plus computer-aided colour measurement system attached with relevant software. Colour fastness to rubbing (dry and wet) was assessed as per IS: 766-1984 method using a manually operated crock meter and greyscale as per ISO-105-AO3 (extent of staining).

The colour fastness to exposure to light (Sun) was determined as per IS: 2454-1984 method. The sample was exposed to UV light in a Shirley MBTF Microsal fade-O-meter (having 500 watts Philips mercury bulb tungsten filament lamp simulating daylight) along with the eight blue wool standards (BS 1006: BOI: 1978). The

fading of each sample was observed against the fading of blue wool standards (Boonroeng et al. 2009; Bhuyan and Saikia, 2005; Kumaresan et al. 2010; Mongkholrattanasit and Kryst fek, 2010;).

The colour fastness to perspiration assessed according to IS 971-1983 composite specimen was prepared by placing the test specimen between two adjacent pieces of fabrics of cotton and stitched all among four sides. The sample was soaked in the test solution (acidic /alkaline) separately with MLR 1:50 for 30 minutes at room temperature. The sample was then placed between two glass plates of perspirometer under a load of 4.5kgs (10 lbs). The apparatus was kept in the oven for four hours at 37±2 ˚C. At the end of this period, the specimen was removed and dried in air at a temperature not exceeding 60 ˚C. The test cotton samples were graded for change in colour and staining using grey scales.

3. RESULTS & DISCUSSION

The colour strength values of cotton samples with the flower of *Tecoma capensis* obtained in this study by using the single mordanting method are presented and compared in Tables 2, 3 and 4.

Table 1. Colour Fastness to Washing

Dyestuff	Mordant	Colorfastness to washing			
		Change in colour		Staining on	
		Dyed Fabrics		Dyed Fabrics	
		Dyed	Nano dyed	Dyed	Nano dyed
Flower of Tecoma capensis	Nickel sulphate	3	4/5	3/4	4
	Aluminium sulphate	2/3	3/4	3/4	4
	Potassium dichromate	3/4	4	4	4
	Ferrous sulphate	3/4	4/5	4	5
	Stannous chloride	3/4	5	3/4	4
	Myrobolan	2	3/4	3/4	4

Table 2. Surface Colour Strength of *Tecoma capensis* Dyed Cotton Fabric after Pre, Simultaneous and Post Mrdanting Methods by Using 1% Mordant Concentration. K/S Vvalue without Mordant: cotton-1.52

Mordant concentration:1%	K/S(λ =420 nm)		
	Pre mordanting	Simultaneous mordanting	Post mordanting
Nickel sulphate	1.50	2.48	2.11
Aluminium sulphate	1.57	2.83	2.68
Potassium dichromate	1.30	1.36	1.40
Ferrous sulphate	1.82	2.93	2.79
Stannous chloride	1.73	2.60	2.44
Myrobolan	1.23	1.28	1.36

Table 3. Surface Colour Strength of *Tecoma capensis* Dyed Cotton Fabric after Pre, Simultaneous and Post Mordanting Methods by Using 2% Mordant Concentration. K/S Value without Mordant: Cotton-1.52

Mordant concentration:2%	K/S(λ =420 nm)		
	Pre mordanting	Simultaneous mordanting	Post mordanting
Nickel sulphate	1.50	2.52	2.22
Aluminium sulphate	1.81	2.87	2.67
Potassium dichromate	1.30	1.31	1.42
Ferrous sulphate	1.85	3.03	2.89
Stannous chloride	1.71	2.74	2.44
Myrobolan	1.23	1.28	1.32

Table 4. Surface Colour Strength of *Tecoma capensis* Dyed Cotton Fabric after Pre, Simultaneous and Post Mordanting Methods by Using 3% Mordant Concentration. K/S Value without Mordant: Cotton-1.52

Mordant concentration:3%	K/S(λ =420 nm)		
	Pre mordanting	Simultaneous mordanting	Post mordanting
Nickel sulphate	1.47	2.51	2.21
Aluminium sulphate	1.82	2.90	2.73
Potassium dichromate	1.33	1.30	1.48
Ferrous sulphate	1.92	3.13	2.84
Stannous chloride	1.80	2.87	2.41
Myrobolan	1.27	1.38	1.43

The above results show that the colour produced normally depends on the mordant used because different mordants produced different colours. The pattern of colour reflectance of dyed fabrics is almost the same. However, the differences were in terms of shades obtained and among five different mordants, dyeing with ferrous sulphate produced the deepest colour for both dye and nano-sized dye form.

Table 1 shows that the colour fastness was in the range of 2/3 to 4/5 for change in colour and 3/4 to 5 for staining. As may be seen in the tables, good staining on cotton can be observed in all dyes with raw dye and nano-sized dyes. However, the change in colour after washing might be due to the dye detached from the substrate because of the dye-fibre bond between the natural dye and the fiber was strong when nano-sized particles were used.

From the above results, it was observed that Tecoma capensis showed better colour strength values. In all three dyeing methods, the simultaneous method gave excellent results. Comparing all the three dyeing methods, the mordants ferrous sulphate and aluminium sulphate show excellent colour strength values. For dyeing of cotton, 1%, 2% and 3% mordant concentrations were used for the present study. Among the three concentrations, 3% mordant concentration gave better results. The binding is more when nano-sized particles of natural dye is used in this study.

CONCLUSION

Conversion of nano-size of dye particles then applied on the fabric gives excellent results. Comparing all the three dyeing methods, the simultaneous method gave excellent results. Similarly, comparing the three dyeing methods, the mordants ferrous sulphate and aluminium sulphate show excellent results. From the study of fastness properties and the colour strength of the dyed samples, Tecoma capensis in simultaneous mordanting method with 3% mordant combination gives better results.

ACKNOWLEDGEMENT

The author is thankful to Dr. T. Balamurugan, Principal, Arasu Engineering College for the support for the completion of this work.

REFERENCES

Bhuyan, R. and Saikia, C. N., Isolation of colour components from native dye-bearing plants in northeastern India, *Bioresource Technology*, 96(3), 363-372(2005). https://dx.doi.org/10.1016/j.biortech.2004.02.032

Boonroeng S, Boonkerdrum P, Chadee and Boonroeng S, Boonkerdrum P, Chadee and Sangkumpra R. *International Conference on the role of Universities in Hand-on Education, Rajamangala University of Technology Lanna*, Chiang-Mai, Thailand, 01-07, (2009).

Kumaresan, M., Palanisamy, P.N. and Kumar, P.E., Application of eco-friendly natural dyes on Cotton obtained from the stem of *Achras sapota* using combination of mordants, *Nat. Env. Poll. Tech*., 9(3), 547-552(2010).

Mongkholrattanasit, R., Kryšt fek, J. I., Wiener, J., Dyeing and Fastness Properties of Natural Dyes Extracted from Eucalyptus Leaves using Padding Techniques, *Fibers and Polymers*, 11(3), 346-350(2010). https://dx.doi.org/10.1007/s12221-010-0346-8